INTEGRATION PROJECT EXPERT PANEL

Closeout Report for Panel Meeting of September 26 - 28, 2001

Prepared by the Integration Project Expert Panel

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APPENDICES

Executive Summary

This is the closeout report for the tenth meeting of the Integration Project Expert Panel (IPEP) held at Hanford on September 26-28, 2001.

GENERAL SESSIONS

Senior DOE management at Richland (DOE-RL) appears to be giving increased recognition to where the Integration Project (IP) fits into the Hanford Vision. Senior management also acknowledged the IP's potential to assist in the development of near- and long-term clean-up strategies for Hanford and the capability of the System Assessment Capability (SAC) model to provide new insights, even at the Rev. 0 level. The remediation of contaminated groundwater (not just its monitoring) is also being recognized as a significant challenge that must be more creatively addressed.

Somewhat mixed messages were received from DOE-RL management regarding the future of integration at Hanford in general and the IP in particular. DOE-RL appears to understand the need for careful planning and discipline in the transition of the IP contract to Fluor Hanford and apparently plans to continue some aspects of the integration begun by the IP, although the scope and location are not defined. Based on comments at the meeting, little progress was apparent in moving that task forward. Many uncertainties remain with significant potential to set back the important task of integration across the Hanford site. It is important that the integration begun by the IP be continued and even broadened under the new contract.

The recent National Research Council (NRC) review of the Science and Technology (S&T) program provides a strong endorsement of the effort that has been underway, along with some good suggestions for improvement. We were pleased to learn that more Environmental Management Science Program (EMSP) funding is being considered. By continuing a strong link with the core projects on site, the S&T program will retain its relevance and value to the remediation decisions that must be made regarding the vadose zone, groundwater and river environments.

SAC ROLLOUT: INITIAL RESULTS

In the focus session on SAC Initial Results, we were provided with results from at least 11 realizations of contaminant transport using all four SAC model modules: inventory, vadose zone, ground water and Columbia River. The computed results will need to be modified as more precise information is obtained for a final report; however, the intended outcome of proof of the SAC concept in Rev. 0 was well demonstrated. Of particular interest was the degree to which the model can already be used to allow users to make some preliminary observations and draw insights that will help in planning future work. The IPEP commends the SAC Team on successfully bringing the models to a level of proof-of-principal functionality

The Rev. 0 task was intended to prove that the SAC method is competent and to create a baseline computational tool from which improvements could be made in subsequent revisions for use in many different decision-making applications. The results of the SAC Rev. 0 simulations are themselves quite informative. Some effort should be made to use Rev. 0 to draw conclusions to whatever extent possible, before moving to design of Rev. 1.

Now that the proof of concept has been established, the scope of the SAC model has been identified and further development of SAC is proceeding, the SAC team will have options for enhancing modeling capabilities. These enhancements should be prioritized to address the anticipated site decisions. Consequently, for this and other reasons, it is essential that key site decisions as well as other project decisions that could benefit from SAC be identified, prioritized, and documented by DOE-RL, as soon as possible.

Because of its importance and its complexity, SAC should be peer reviewed by outside independent reviewers. The peer review must occur prior to the development of detailed plans for Rev. 1, but subsequent to appropriate and sufficient documentation for a detailed technical assessment, including information posted on the SAC web site. If SAC Rev 0 is not documented until planning for Rev. 1 is complete, the recommended peer review will not be effective and will have little influence on Rev. 1. Although the groundwater module has been reviewed by outside technical experts and may not need the same level of scrutiny as the balance of the SAC model, the review should include all four SAC modules: inventory, vadose zone, ground water and river.

SAC Rev. 0 appears to be quite useful as a qualitative visualization aid and is likely to provide insights that will be valuable in assessing field data, improving conceptual models, and planning future work. These and other potential uses of Rev. 0 must be carefully tempered by an understanding of the possible errors and uncertainties, and it is incumbent upon the SAC team to include appropriate caveats in any presentation or publication of results. Bringing SAC on-line as a reliable decision making tool will require a careful, open, iterative process of development, testing, and independent review.

SAC ROLLOUT: INVENTORY

Our impression based on the presentations was that the initial effort at establishing a SAC inventory represents a good first pass at a big job. The SAC team identified weaknesses that they are now addressing. The first version of the SAC inventory has some intentional limitations, such as being limited to ten contaminants and being based on a limited subset of inventory records.

During the open discussion, it became evident that the interface between the IP and some core projects needs further attention. At the least, we observed a communication gap. Data that are needed by SAC, but are under the control of the core projects, must be available when needed and provided in an appropriate format. This may include developing and maintaining additional databases beyond the core project needs. If SAC needs such additional data, DOE-RL must ensure that they are available.

As described at the IPEP meeting, the method by which waste inventory is counted and labeled for the SAC is confusing and apparently inconsistent. For example, tank waste is not counted as part of the waste inventory until it is removed and processed, while some other forms of waste, such as fuel rods in the K-basin, are considered as part of the waste inventory from the beginning. It is our view that all waste material on site should be considered part of the initial waste inventory and that inventory should be tracked "from cradle to grave" onsite. Maintaining scattered, diverse and complex sets of inventory databases is neither cost effective in the long term nor technically suitable in the near term. Common definition as to what constitutes a "waste" is a must for credible selection of options, as well as for obtaining credible estimates of the hazard presented by the options selected or rejected.

While the SAC inventory database is a good first pass, it will ultimately need to be based on a detailed site-wide inventory under configuration control that is used by everyone. It seems reasonable for the IP to maintain the comprehensive inventory database.

GROUNDWATER REMEDIATION SYSTEMS

Operational Status of Pump-and-Treat Systems

The Hanford Site has 11 groundwater remediation systems in the four National Priorities List (NPL) areas into which the Site is divided. Within the 100- and 200-Area operating units (OU), there are several identified groundwater contaminant plumes undergoing treatment using five groundwater pump-and-treat systems; three in the 100-Area OU and two in the 200-Area OU. Monitoring data continue to show that the pump-and-treat systems are achieving plume capture, but gaps in the hydraulic barriers exist.

Although performance of the groundwater remediation systems in the 100 Area is well documented, the success of each is difficult to assess, because of uncertainties in specific performance targets, as well as variability in reported monitoring results from compliance wells. In a previous report, the IPEP noted that monitoring data from several compliance wells in the 100 Area failed to show conclusively that the pump and treat systems were approaching performance goals for reducing the net mass discharge of Cr(VI) into the Columbia River. Fluctuations in reported Cr(VI) concentrations, apparently due in part to fluctuations in water levels along the Columbia River, make data interpretation difficult. This situation still exists, as shown by continued fluctuations in Cr(VI) levels in compliance wells downgradient of the pump and treat systems.

EPA's Five-Year Review

EPA's Five-Year Review [US EPA, 2001] evaluated groundwater data obtained by DOE over the past several years to document compliance with the goals of the Interim Remedial Actions for the groundwater OUs in the four NPL sites. Of the 18 action items, 12 relate to groundwater problems.

Based on information provided in the Review, EPA and the Washington Department of Ecology (Ecology) appear to be satisfied with the level of detail provided by the DOE on the performance of the groundwater remediation systems. The IP is responding appropriately to requests in the Review to improve system performance. Unfortunately, regulatory goals in some instances are not explicitly defined and the time required to achieve presumed cleanup goals has not yet been estimated for any of the plumes. Optimization of remedial strategies requires explicit definition of goals and specific cleanup target levels, definition of points of compliance, and what constitutes a "reasonable time frame" for cleanup.

In-Situ Redox Manipulation (ISRM)

Although the installation of the ISRM barriers has diminished the amount of chromium discharged to the Columbia River, recent high levels of Cr(VI) downgradient of the barrier raises concerns about the long-term viability of this innovative technology. Indications are that in a short time from installation the residual reductive capacity of the treated aquifer has been substantially depleted within the central portion of the treatability test area. Accelerated depletion of the aquifer's reductive capacity may have been caused in part by heterogeneity of the aquifer, a fluctuating water table, and variability in the reduced iron content, among other possible reasons. The IP has prepared an ISRM Mitigation Plan designed to determine the cause of the problem and to institute remedies that will permit continued deployment of the ISRM barrier to meet the design objectives. Re-injection of dithionite in spring 2002 was selected as the mitigation action, with a projected completion date of December 2002.

The apparent rapid loss of reductive capacity of the ISRM barrier is a cause for concern, because considerable effort has been invested in this technology and the technology has been broadcast as a significant success story regarding DOE investments in technology development. The proposed mitigation plan represents a positive response to the problem and may be appropriate. However, insufficient evidence has been provided for IPEP to evaluate its potential for successful mitigation. Sufficient resources should be devoted to this effort to ensure that the cause of the problem is clearly defined and, if possible, a successful remedy found.

Justification for the installation of the ISRM technology was largely based on a life cycle cost comparison against that of the conventional pump-and-treat technology. New data collected as part of the mitigation plan should provide a basis for reassessing the life-cycle advantages of the ISRM. The life-cycle cost of this technology is sensitive to the assumed life of the ISRM barrier, and a revised cost comparison should be completed to enhance the technical credibility of the technology.

Improved or Alternative Technologies

The EPA Review identified the need for improved pump-and-treat system performance for the ^{90}Sr plume in the 100 Area, for the carbon tetrachloride plume in the 200 Area, and for the ^{99}Tc and uranium plumes in the 200 Area. DOE noted these technical challenges, and the technical elements are intended to be included in the S&T roadmap. Improved or alternative technologies for groundwater remediation are needed, and coordination with the S&T program should continue, but it is not clear how the ongoing technical reviews will be integrated into the current groundwater remediation program.

Pump-and-treat operations for ^{90}Sr began in 1995 and the rate of plume migration to the river has been reduced, largely as a result of a reduction in the hydraulic gradient. However, less than 1 curie of ^{90}Sr has been removed since inception of the groundwater extraction and treatment system and that at a unit cost of $4.3-million per curie of ^{90}Sr removed (see Appendix B, Table B3, this report). The high unit cost and the very low rate of contaminant removal clearly indicate the need for alternative remediation strategies for this plume. We previously urged the IP to consider natural attenuation as a remedy for this plume. We reiterate that recommendation in this report.

Cost is a factor to consider for other mitigation strategies in addition to those for the ^{90}Sr plume. For example, pump-and-treat removal of Cr(VI) costs approximately $19,000 per pound of Cr(VI) removed at the 100-KR-4 Area and nearly $34,000 per pound removed at the 100-HR-3 Area (see Appendix B, Tables B1 and B2, this report).

The IP is pursuing a number of options to evaluate and possibly select alternative technologies for the various groundwater plumes in preparation for determining the final remedy for each plume. It was not clear from the presentation during the September meeting, nor from the documents provided, how the technology selection process will work. We thus recommend that any plans developed by the IP in response to the Innovative Treatment and Remediation Demonstration (ITRD) program review being completed by Los Alamos National Laboratory be subjected to an external peer review to enhance their usefulness to resolve the remediation challenges at the Hanford Site.

Optimization of any specific groundwater remediation system will require site-specific models and other site-specific analyses. However, the SAC model can potentially be used to compare the impact of different groundwater remediation strategies on specific plumes to provide a basis for prioritizing investments in new technologies, or in optimizing currently installed technologies. It is not possible to specify when the SAC can achieve the level of credibility needed to fulfill this need for groundwater remediation systems, but we urge that this use of the SAC be given serious consideration.

RECOMMENDATIONS

General Sessions

1. DOE-RL needs to place greater emphasis on defining the role of IP with respect to local, as well as site-wide decisions.
2. Near-term efforts by the IP on SAC Rev. 0 should focus only on removing significant deficiencies and building confidence in the results being produced, not adding more features.
3. An explicit and comprehensive plan for the transition of the Integration project between Bechtel and Fluor is needed now, with appropriate deliverables and performance metrics assigned to all participants. The plan needs to emphasize maintaining and strengthening the integration culture at Hanford.
4. The IP should perform more extensive analyses of the tritium data from the burial grounds, the groundwater, and the vadose zone around the burial grounds to address important unresolved issues.

SAC Rollout: Initial Results

1. The SAC team should produce a white paper identifying the gaps in data, so that site and core-project planning can include tasks to address identified data needs, such as ^{99}Tc inventory or carbon tetrachloride degradation rates, now rather than after the final Rev. 0 documents are released.
2. The SAC team should establish explicit criteria for closeout of Rev. 0, so that work on Rev. 1 may begin.
3. The SAC team should provide easy access, perhaps web based, to information used in Rev. 0 regarding methods, databases and other factors that are not defined in the original SAC design document.

4. Key site decisions that can benefit from SAC modeling must be identified soon in order to affect the design of SAC Rev. 1.
5. The IP should conduct an independent peer review of the entire SAC Rev. 0 model, including all four modules, before plans for Rev 1 are finalized.
6. The needed confidence building should also include SAC team re-examination of data, tabulation of statistical data that support error and uncertainty analysis of the simulations, and development of visuals that demonstrate performance of the model versus known data.
7. The SAC team should focus on making its upcoming presentations to the public on the results of SAC Rev. 0 especially clear and well thought out, giving particular attention to the challenge of maintaining technical credibility while conveying content in an understandable manner to a diverse audience having a variety of biases and cultures.

SAC Rollout: Inventory

1. DOE should ensure that the IP has efficient access to needed data under the control of the core projects.
2. DOE and regulators should achieve a common, credible definition of what constitutes waste at Hanford and all waste should be listed in the SAC inventory.
3. DOE should ensure that a detailed site-wide inventory under configuration control is available as needed to support the SAC inventory project.
4. SAC should document the status of the SAC inventory project in a white paper or other appropriate form.
5. DOE should include relevant inventory issues as part of the SAC external peer review.
6. DOE should ensure that assignments of authority and responsibility regarding the working interface between the IP and relevant core projects are clear and appropriate for efficient interaction.

Groundwater Remediation Systems

1. Continue efforts to enhance the pump and treat systems to meet regulatory compliance goals.
2. Resolve the cause(s) of the observed breakthrough of Cr(VI) at the ISRM barrier.
3. Once the cause(s) of the decreased capacity of the ISRM barrier have been determined, reassess the cost-effectiveness of the ISRM on the basis of life cycle costs.
4. As confidence builds in the accuracy of the SAC, use this tool to assess priorities for technology selection and system optimization within the groundwater remediation program.
5. Because of the high cost of the pump and treat system for the ^{90}Sr plume, a rigorous analysis of the natural attenuation option should be a key part of any technology evaluation for this plume.

6. IP's plans to implement recommendations coming from the review by the ITRD should be subjected to an external peer review to facilitate the selection of alternative remedial technologies for the groundwater remediation program.

1. INTRODUCTION

This is the closeout report for the tenth meeting of the Integration Project Expert Panel (IPEP) held at Hanford on September 26-28, 2001. Compared with previous IPEP meetings, this meeting was held under somewhat difficult conditions, precipitated to some extent by the terrorist attacks of September 11 and the many ensuing uncertainties that developed as a result. The meeting dates were also the last three days of the fiscal year, a time period when many deliverables are due.

Although some consideration was given to postponing the meeting until a later date, the ultimate decision was to proceed as originally planned. The IPEP members believed that this was an opportune time for a review of the progress of key issues that might affect deliberations on uncertainties in DOE budgets affecting the Integration Project (IP) for FY02 and plans for transitioning of the IP to Fluor Hanford. Despite a shortage of new documents for the IPEP to review prior to the meeting, discussions between IPEP and IP contacts for the focus sessions led to the conclusion that new information could be transmitted to the IPEP for its evaluation.

Despite the difficult circumstances, the meeting provided a forum for a year-end status review of the IP. It obviously took time for the Richland DOE (DOE-RL), IP, and core-project staff to pull together all the presentations and information provided during the meeting. The IPEP members appreciate the hard work of those IP and core project staff that helped to make the meeting a success.

While the IPEP set the specific objective for this meeting of dealing mostly with subjects for which there was relevant written documentation for review prior to the meeting, we did not achieve this goal. Consequently, we have based much of this report, on the verbal presentations. In some cases, such as the rollout of new modeling results from the System Assessment Capability (SAC), a lack of documentation is understandable. For those programs where an extensive operating history exists, absence of documentation is not an optimum situation for a review panel and has been a source of frustration for the IPEP. We will work with IP to improve this aspect of future meetings.

2. GENERAL SESSIONS

The morning of the first day of the meeting was devoted to a general overview of site management's concepts for cleanup and of projects affected or managed by the IP (see Appendix A, September 26 – 28, 2001 Agenda).

2.1 Hanford Vision Update

Senior DOE-RL management appears to be giving increased recognition to where the IP fits into the Hanford Vision. Senior management also acknowledged the IP's potential to assist in the development of near- and long-term clean-up strategies for Hanford and the capability of the SAC model to provide new insights, even at the Rev. 0 level. The remediation of contaminated groundwater (not just its monitoring) is also being recognized as a significant challenge that must be more creatively addressed on site. DOE-RL management continues to stress that they value independent reviews of various types, not only by groups like the IPEP, but also by the National Research Council (NRC) of the National Academy of Sciences and technical peers. These reviews help to maintain the integrity of the IP.

Somewhat mixed messages were received from DOE-RL management regarding the future of integration at Hanford in general and the IP in particular. DOE-RL appears to understand the need for careful planning and discipline in the transition of the IP contract to Fluor Hanford and apparently plans to continue some aspects of integration begun by the IP, although the scope and location are not defined. Based on comments at the meeting, little progress was apparent in moving that task forward, however. Many uncertainties remain with significant potential to set back the important task of integration across the Hanford site. It is important that the integration begun by the IP be continued and even broadened under the new contract.

The IPEP is also heartened that the Science and Technology (S&T) program remains such a visible and vital part of the IP effort. The recent NRC review of this program provides a strong endorsement of the effort that has been underway, along with some good suggestions for improvement. We were pleased to learn that more Environmental Management Science Program (EMSP) funding is being considered. By continuing a strong link with the core projects on site, the S&T program will retain its relevance and value to the decisions that must be made regarding remediation of the vadose zone, groundwater and river environments.

Brief mention was made of a new collaborative effort to improve decision making at Hanford under the rubric C3T (Cleanup Constraints Challenges Team). Although we requested more information on that initiative, none was provided at the 3-day meeting or in the weeks since that time. The lack of information makes it difficult for us to comply with requests to review or evaluate priorities being established by the IP in view of the specific visions being crafted by DOE-RL and its partners.

The Central Plateau Risk Assessment Workshops, spearheaded by the IP and the regulators (EPA and Ecology), have the potential to achieve consensus on both "End Points" and "End States" related to the Central Plateau. The Risk Assessment Workshops are discussed in Appendix B of this report.

2.2 Status of the Integration Project

The end-of-the-fiscal-year status report on the IP presented by BHI Project Manager Michael Graham separated activities into three categories of work depending on whether it was done in support of river corridor cleanup, central plateau decisions, or Hanford site integration. The IPEP found this separation useful for supporting the evolving Hanford Vision as well as to understanding how individual work elements fit into a larger picture.

The status report contained an impressive set of work activities conducted by the IP. More importantly, the report focused on solid accomplishments from work that has been conducted "in the field" to support the groundwater remediation effort, the 200 Area remediation program, characterization studies, investigation of tank farm leaks, S&T program, SAC, and site-wide data bases. Each of these achievements represents important work being done in the field that is intended to support river corridor cleanup, central plateau decisions, or Hanford site integration. It is clear that the spirit of integration has gained additional momentum over the past year, allowing the IP to complete tasks and develop new information that leads to new interpretations and improved priorities. Compared with historical (and typical) levels of progress made at Hanford, the IP is to be commended for its work over the past year.

As previously indicated, the NRC has published a generally positive and cautiously optimistic review of the IP's S&T program. The IPEP is pleased that the review of this program was positive, especially considering the fact that this prestigious organization has often been highly critical of DOE programs in the past. We commend IP planning efforts in FY02 to revise the S&T roadmap to reflect NRC comments and prioritization based on the initial results obtained with the SAC. For example, the NRC cautioned that conducting only 11 realizations for SAC Rev. 0 is likely to be insufficient to validate the methodology and convey confidence in future results from the SAC.

The IPEP agrees that site-wide modeling coordination is a good idea, and we are pleased that DOE-RL management has agreed to lead the effort. While the effort is still in its early stages, we believe it would benefit greatly by having a defined scope, clear goals and objectives, and some measures of success. Also, careful consideration should be given to the possibility of reducing the number of models (and modeling groups) being used across the site by integrating the modeling effort as much as is feasible.

Finally, it appears more certain that transition of the IP to Fluor Hanford is coming, with timing being the greatest uncertainty. At the time of the IPEP meeting, however, the terms of this transition were still not adequately defined. While we recognize that there are numerous considerations involved with this transition, it is essential that a transition plan be agreed upon as soon as possible, preferably one that will allow all of the momentum and benefits achieved by the IP to be retained. Otherwise, important work may be lost and money wasted.

2.3 Focused Project Updates

2.3.1 Tritium Investigation at Burial Area 618-11

This investigation is a good example of how the IP was able to respond to an unanticipated event that caused a great deal of concern, because of proximity to the Columbia

River. IP was able to quickly put a team together, developed a drilling plan and set it into action. Several boreholes were completed in a relatively short time, and a large number of soil-gas samples were collected using a cone penetrometer.

A preliminary analysis of the data [Borghese et al, 2001] shows that the tritium plume from the 618-11 burial area is relatively narrow and moving from the burial ground in an east/northeast direction. Although the plume analysis was incomplete at the meeting, continuing data collection presents a unique opportunity for groundwater model testing. Changes in concentration of tritium (and other contaminants around the site) over time are generally treated (or at least presented) as simple one-dimensional flow with true changes of concentration with time - a slug of contaminant moving through, for example. Based on the meeting presentation, the possibility of varying flow paths (horizontal and/or vertical direction changes) over time does not appear to have been given adequate consideration as an alternative explanation for the change. As the plume is better defined and data become available on the 3D nature of the plume, this information could be used to further test the Hanford Groundwater Model. Testing of this model with independent data sets is still a high priority goal.

Although the field characterization task as originally defined is finished and the final report is being written, it appears to IPEP that several issues about the distribution of tritium remain unresolved. First the vertical concentration of tritium in groundwater samples continues to increase with depth of sample, implying that neither the base of the plume nor the maximum concentration of tritium at depth has yet been determined. These unresolved issues should be addressed to assist in defining the mass of tritium released and to develop a conceptual model of migration. It appears anomalous to have the tritium penetrate to such depths in groundwater rather than migrate principally along the upper portion of the groundwater free surface.

Second, this anomalous behavior raises a number of additional questions that should be addressed. Why did the tritium suddenly appear in the groundwater east of the burial ground? If the burial ground was operated from 1962 through 1967, why did it take so long for tritium to appear in the groundwater and in well 699-13-3A? What changes at the burial ground or with the groundwater gave rise to increased tritium levels in the groundwater east of the burial ground? Did accumulated recharge finally move the tritium into the groundwater due to inadequate cover over the burial ground? A more extensive analysis of the tritium data from the burial ground, the groundwater, and the vadose zone around the burial ground is strongly recommended.

The use of $^{3}He/^{4}He$ sampled in the vadose zone as a surrogate to indicate the location of elevated tritium concentrations in the groundwater is reasonable. However, it is also a standard practice to sample for tritium at the same location when helium is sampled, whether in the groundwater or vadose zone (Solomon et al., 1996). The sample collection for water in the vadose zone is not difficult and would assist in defining the positional relationship between tritium and He distributions. The collection of tritium water and vapor samples is well documented and the analysis is relatively inexpensive. The resulting data can further assist in defining a conceptual model for tritium migration in both groundwater and in the vadose zone as fluid and vapor.

2.3.2 200 Areas ER Remedial Action field Investigation

The apparent anticipation of encountering perched zones during drilling resulted in a program designed for sampling these zones. It now appears Tc may be present in some of the perched zones and the confirmation of this will assist inventory calculations of mass distribution.

2.3.3 Tank Farm Vadose Zone Investigations

The River Protection Program (RPP) effort to define the vadose zone in the tank farms appears to be a technically strong effort. How much characterization is needed is a question that will remain unanswered until the long-term site-wide cleanup goals are determined.

2.3.4 S&T Vadose Zone Field Investigation

This seems to be a well performed and important study. While the team may be well aware that this is not a controlled experiment (nor can it be), they did not mention that important fact when they presented conclusions. For example, they drew conclusions about the transport of high-salt solution vs. dilute solution without discussing the perturbing effect of introducing the high-salt solution into a region already wetted by the dilute solution.

2.3.5 Modeling Coordination

This effort appears to be in an early, information gathering stage. We emphasize our earlier recommendation that the various modeling efforts should be integrated as much as is feasible and the possibility should be carefully considered that integration could allow reducing the number of models (and modeling groups) being used across the site.

2.4 Overarching Comments Regarding Integration

From several years of reviewing the IP, the IPEP offers several comments regarding integration and the relevance of the IP in assisting with site decisions.

- DOE-RL has the responsibility to define and articulate key decisions to be made in association with cleanup of the Hanford site. Thus, DOE-RL ultimately has the responsibility to promote the best approach to site cleanup and coordinate interactions among the site organizations that need to be involved. These are not contractor responsibilities. If integration is pursued as the preferred approach, it will fail unless DOE-RL plays a prominent role in its direction and maintenance.

- The IP, through the contractors, has the responsibility to support integration fully and develop effective tools and knowledge that are directly relevant to site decisions. The contractors must advise DOE-RL regarding weaknesses in the integration process.

- Integration will not be accomplished at Hanford until both DOE-RL and the contractors meet their responsibilities on a mutually supportive basis. While significant progress has been made with respect to integration at Hanford over the past few years, it is not yet a reliable long-term culture onsite, and integration remains a work in progress.

- In this meeting it became clear to us that, unfortunately, all parties do not yet agree on the meaning of the terms “End-Point,” “End-State,” or “End-Game.” We hope that the risk assessment workshops being held to discuss remediation/closure decisions for the Central Plateau can contribute to producing a consistent set of clear definitions.

- Successful integration relies on having a vigorous and open collaboration with the regulators, Indian Nations, stakeholder groups, and the public. To this end, we appreciate all the input we have received from various organizations at the IPEP meetings.

2.5 Overall Conclusions

Based on the information conveyed during this meeting, we reach the following overall conclusions:

- At the present time, the results produced by the IP principally influence limited or localized decisions and actions onsite related to cleanup. The information coming from the IP is still not sufficiently tied to larger site decisions. However, the IPEP believes this is not the fault of the IP. The larger site decisions have not yet been articulated in a way that the IP can use them as a basis for planning its work. The Hanford Vision that is being developed is a key step towards allowing the IP to link its work with key site decisions.
- We are pleased about the initial rollout of the SAC Rev. 0 results that took place at the meeting. As discussed further in a later section, even with its current limitations, SAC can be useful now in confidence building and in providing insights that affect future work.
- The IPEP is concerned about the execution of the transition of the IP to Fluor Hanford. Several years of effort and developed momentum could be compromised or lost entirely if the transition is not executed with great care. It is not clear to us that DOE fully appreciates the potential hazards inherent in this transition.
- If the scope and goals of the IP may be altered, as appears possible with the transition from Bechtel to Fluor Hanford, careful project wide review and DOE-RL oversight are necessary. The current set of activities is to a significant extent the result of collaborative efforts across contractors and other institutions. A new contractor should not have the power to substantially alter those plans without a careful review and acceptance of proposed changes by DOE-RL management.

2.6 Overall Recommendations

1. DOE-RL needs to place greater emphasis on defining the role of IP with respect to local, as well as site-wide decisions.
2. Near-term efforts on SAC Rev. 0 should focus <u>only</u> on removing significant deficiencies and building confidence in the results being produced, not adding more features.
3. An explicit and comprehensive plan for the transition of the Integration project between Bechtel and Fluor Hanford is needed now, with appropriate deliverables and performance metrics assigned to all participants. The plan needs to emphasize maintaining and strengthening the integration culture at Hanford.
4. The IP should perform more extensive analyses of the tritium data from the burial grounds, the groundwater and the vadose zone around the burial grounds to address important unresolved issues.

3. SAC ASSESSMENT ROLLOUT: INITIAL RESULTS

The focus session on SAC Initial Results was a much-anticipated first public demonstration of SAC modeling capabilities. The content for this session was scheduled at the prior IPEP meeting, April 25-27, 2001, based on the SAC progress discussed at that time. The topic was a result of the update given about the "history matching" methods and the reported preliminary results in simulating some known ground water concentration distributions. In this current meeting, we were provided with results from at least 11 realizations of contaminant transport using all four SAC model modules: inventory, vadose zone, ground water and the Columbia River.

The results were presented in several modes, including plume animations of contaminant distribution over time and in terms of uncertainty correlations. In some cases the SAC team employed preliminary assumptions that in retrospect may not be representative, such as the use of fuel ratios to account for sparse data in circumstances for which other methods are clearly better. The computed results will need to be modified as more precise information is obtained for a final report; however, the intended outcome of proof of the SAC concept in Rev. 0 was well demonstrated. Of particular interest was the degree to which the model can already be used to allow users to make some preliminary observations and draw insights that will help in planning future work.

Planning for the SAC project for the coming fiscal year includes correcting some inconsistent or outdated assumptions already identified by the SAC team; re-running the ground water model as a 3-dimensional multilayer code as opposed to the 2-dimensional version currently employed; and improving some key inventory estimates that were evident to the SAC team from the realizations run to date.

3.1 Observations

The IPEP commends the SAC Team on successfully bringing the models to a level of proof-of-principle functionality.

3.1.1 Status of Rev. 0

<u>Objectives</u> The SAC design document [Kincaid et al., 2000] generally identified the objectives for Rev. 0 in terms of a baseline model that was forward looking rather than being useful immediately as a decision-making tool. The four key objectives as summarized by the SAC team for this IPEP meeting were:

- Design and perform a proof-of-principal demonstration of the SAC;
- Obtain information needed for Rev. 1;
- Provide insight for S&T investment; and
- Provide insight into site conditions for site management.

The four objectives are essentially forward-looking in the context of developing a baseline and a plan to do work, as opposed to doing preliminary calculations that can always be refined but are sufficient to draw action items based on the results. The Rev. 0 task was intended to prove that the SAC method is competent and to create a baseline computational tool from which improvements could be made in subsequent revisions for use in many different decision-making applications.

It is our observation that the results of the SAC Rev. 0 simulations are themselves quite informative. Some effort should be made to use Rev. 0 to draw even limited conclusions to whatever extent possible, before moving to the design of Rev. 1. For example, it may be that one can conclude sorption constants for some nuclides and abiotic degradation rates are significantly affecting transport, and thus better empirical definition is required. It also appears that better accounting of inventory for radionuclides such as ^{99}Tc may greatly reduce uncertainty in the assessment of migration rates and the assessment of risk at the river. Furthermore, it seems clear that there is great value in including multilayer descriptions of the vadose zone and multidimensional flow in the groundwater; however, computational capabilities will need significant improvement before these options can be exercised.

<u>Data Needs</u> The current schedule pushes the date for publication of Rev. 0 documentation from the March 2001 time frame until the end of FY02. The IPEP understands the rationale for delaying this documentation; principally so that the additional corrections to the model can be made and new simulations as well as alternative scenarios can be run using the model to provide "publishable" results for documentation of the project. Nevertheless, a significant time savings might accrue if data needs can be made known sooner, so that core projects as well as the IP can incorporate tasks in their plans for the next fiscal year to address these data needs.

The SAC team should prepare a white paper as soon as is practical to identify the data needs discovered during the processing of Rev. 0, with a discussion of precisely what information could most significantly impact reduction of uncertainty in the SAC calculations. Again, referring to the earlier example, one might proceed to resolve the inconsistency in the concentration and location of ^{99}Tc as measured in groundwater compared to SAC simulations of ^{99}Tc in the groundwater based on available inventory models. A second example might be the need to collect data for biota at the same location as was/is used for collection of samples for water chemistry and sediment samples.

Coordinated data collection, integration, and interpretation efforts, will improve our understanding of the biological consequences of contaminants and their spread in the environment. If model coordination at the S & T Level does not include such explicit connections to biological consequences, there is little hope that Site-Specific Level, Side-Wide Level, and Strategic Level models and decision making can be appropriately tuned to avoid ecological risks or avoid expenditures that do little to reduce those risks.

<u>Key Decisions</u> Now that the proof of concept has been established, the scope of the SAC model has been identified and further development of SAC is proceeding, the SAC team will have options for enhancing modeling capabilities. These enhancements should be prioritized to address the anticipated site decisions. Consequently, for this and other reasons, it is essential that key site decisions as well as other project decisions that could benefit from SAC be identified, prioritized, and documented as soon as possible.

Closeout. The FY02 schedule and scope for work on Rev. 0 have been approved, but it is not clear that explicit criteria have been established to complete the task. Undoubtedly as the Rev. 0 presentations are made to IP and core project personnel, stakeholders, regulators, and Indian Nations, the expectations of Rev. 0 will increase. It is essential for a successful closeout of this part of the SAC project that a strategy be developed immediately to avoid additional delays in completing this phase of SAC Rev. 0 development. Then the project personnel can begin work on Rev. 1.

3.1.2 Publication of SAC Methodology

The methodology and data sources of the SAC modeling effort may result in questions and challenges by many interested constituencies. It seems both prudent and efficient to provide a centralized and accessible source for obtaining the needed information. Much of the detail of SAC procedures and methods is defined in the original SAC design document [Kincaid et al, 2000]; however the actual data used in the simulations and the changes to equations, procedures and methods are not in this document. IPEP suggests that one possible way to deal with this issue before the final SAC Rev. 0 report is written is to post the data bases, equations, and modifications to methods on the existing web site, with instructions for browsing. At this early stage of development, there may already exist significant confusion about the way the calculations are constructed and which specific input data were used. This open examination of the infrastructure of SAC should be quite useful in building consensus and providing public assistance in defining areas of uncertainty, as well as evoking suggestions on how to reduce the uncertainty in defining the risk. This web site could serve a second important purpose by providing information needed for an effective peer review of Rev 0, as recommended below.

3.1.3 Confidence Building

Peer Review Building confidence in the SAC model and developing a consensus among the users of SAC results that it will be a useful tool to support decision-making, as well as for affecting design and priority of cleanup, will require a concerted effort. Because of its importance and its complexity, SAC should be peer reviewed by outside independent reviewers. The peer review must occur prior to the development of detailed plans for Rev. 1, but subsequent to appropriate and sufficient documentation for a detailed technical assessment, including information posted on the SAC web site as recommended above. If SAC Rev 0 is not documented until planning for Rev 1 is complete, the recommended peer review will not be very effective and will have little influence on Rev 1. Although the groundwater module has been reviewed by outside technical experts, and may not need the same level of scrutiny as the balance of the SAC model, the review should include all four SAC modules: inventory, vadose zone, ground water and the river.

Uncertainty The SAC team needs to ensure that they have done all that reasonably can be done within the scope of the Rev. 0 task to ensure the data are reliable, and the gaps have been identified for attention in future revisions. Peer review and public questioning will probe this level of detail and the team must be prepared to defend the work to date and be in agreement that the work is sufficient for this point in the development of the SAC capability. Beyond this is the need for next generation versions, beginning with Rev. 1, to rigorously test and "validate" the model by comparison with actual measurements wherever possible. Numerous realizations, and rigorous statistical treatment of limits of uncertainty are a requirement for each contaminant and each module as well as the whole of the SAC simulation.

Public Confidence The presentations being made to interested parties must include validation graphics. Confidence in the model will be affected greatly by visible and clear evidence of success in matching existing data. There exists a technically trained audience interested in the statistical validity of the modeling approach. Information on the details of stochastic modeling must be available, e.g. the parameters varied among realizations and their ranges; the uncertainty in results as "snapshots" at various time periods, and the correlations and cross-correlations of variables that most directly affect results and consequently may need additional attention in future revisions.

3.2 Concerns

IPEP notes that in addition to the requirement of convincing the technical users that the SAC is "valid" in comparison to existing data, statistically and computationally defensible, and arguably well suited for prediction, clear communication is also critical for success in public presentations. The SAC task has been under development for several years and now is the time to present the capabilities and plans to the technical users and to the public in a thoughtful way. The language used in IPEP sessions in many instances was couched in technical terms that do not usually communicate well to the non-technical part of the public community (and often are unclear even to the technical community). Because building confidence is essential and because there are few opportunities to "get it right the first time", we note this concern.

The output of the SAC Rev. 0 is sometimes impressive and in instances where the models produce results similar to expectations based on field data, it is tempting to assume that the models are calibrated and functioning correctly. In dealing with large computational models, however, we must keep in mind that spurious agreement, due perhaps to compensating errors or simply coincidence, is always a possibility, especially in a model that has not been thoroughly tested. For now SAC Rev 0 appears to be quite useful as a qualitative visualization aid and is likely to provide insights that will be valuable in assessing field data, improving conceptual models, and planning future work. These and other potential uses of Rev 0 must be carefully tempered by an understanding of the possible errors and uncertainties, and it is incumbent upon the SAC team to include appropriate caveats in any presentation or publication of results. Bringing SAC on-line as a reliable decision making tool will require a careful, open, iterative process of development, testing, and independent review.

3.3 Recommendations

1. The SAC team should produce a white paper identifying the gaps in data, so that site and core-project planning can include tasks to address identified data needs, such as ^{99}Tc inventory or carbon tetrachloride degradation rates, now rather than after the final Rev. 0 documents are released.

2. The SAC team should establish explicit criteria for closeout of Rev. 0, so that work on Rev. 1 may begin.
3. The SAC team should provide easy access, perhaps web based, to information used in Rev. 0 regarding methods, databases and other factors that are not defined in the original SAC design document.
4. Key site decisions that can benefit from SAC modeling must be identified soon in order to affect the design of SAC Rev. 1
5. The IP should conduct an independent peer review of the entire SAC Rev. 0 model, including all four modules, before plans for Rev 1 are finalized.
6. The needed confidence building should also include SAC team re-examination of data, tabulation of statistical data that support error and uncertainty analysis of the simulations, and development of visuals that demonstrate performance of the model versus known data.
7. The SAC team should focus on making its upcoming presentations to the public on the results of SAC Rev. 0 especially clear and well thought out, giving particular attention to the challenge of maintaining technical credibility while conveying content in an understandable manner to a diverse audience having a variety of biases and cultures.

4. SAC ASSESSMENT ROLLOUT: INVENTORY ISSUES

The second day's morning session on the subject of inventory data bases available for and used by SAC was followed during the afternoon with a roundtable discussion, on the topic, *Inventory As It Relates To Modeling And Assessments At Hanford*. The roundtable discussion provided a less time-constrained opportunity for the IPEP and attendees to explore the limitations of existing inventory databases. This section of the closeout report incorporates observations, concerns and recommendations developed during the rollout and roundtable inventory sessions.

Prior to the meeting, the respective IPEP and Hanford contacts developed a set of five questions to promote audience participation during the roundtable discussion session:

- The inventory for SAC Rev 0 uses input from a variety of databases, information sources, and models. Should this architecture continue? How rapidly should it evolve toward an automated database, (i.e., one that accesses primary inventory sources such as the SWITS, SWIFT, and ERS databases and archived HTWOS and SIM model runs automatically)?
- For a stochastic analysis, the inventory needs to be a central-tendency or best-estimate inventory with associated uncertainty – not a bounded or conservative inventory. Can individual programs produce and maintain such an inventory – especially in light of drivers that now indicate a need for a bounding or conservative inventory? Should the IP be given responsibility for the central tendency and uncertain inventory estimate?
- Can programs identify and maintain a single point of contact for their inventory – i.e., the inventory to be used for modeling and assessments at Hanford? An example is the need for a single point of contact within the RPP organization.
- Hanford is embarking on the recovery of wastes from solid waste burial grounds in the 100, 200 and 300 Areas. What information could be obtained from these remedial actions that would be used by the inventory technical element? Examples are estimates of inventory actually disposed and levels of contamination (i.e., released) in sediments underlying the disposal trenches.
- Based on the work to date and that discussed for the immediate future – should the inventory technical element activities change their focus?

As it turned out, carry-over of issues from the morning presentation and the first and second questions above proved more than sufficient to fill the discussion session. The discussions pointed to issues that require resolution among management, regulatory and technical staffs. In the case of the first question, time and effort necessary to restructure historical databases and the duplicative effect of having to maintain some databases using formats dictated by regulatory requirements require early investment of manpower and time in order to realize benefits at some later time – always a dilemma in periods of tight budget. The second question, concerning best estimate versus bounded inventories, is a philosophical as well as regulatory and technical issue. Much regulatory philosophy is built on bounding calculations, using relatively simple and simplistic models, whereas the SAC system, using central tendency, can provide a more comprehensive and possibly more representative "picture' of the level of risk at Hanford.

Although the third through fifth questions were not discussed during the roundtable session, they are maintained in this report for future consideration.

4.1 Observations

As part of the SAC Rollout Session, the IPEP was given a briefing on inventory issues related to SAC. Although the IPEP had little written material directly relevant to the meeting for review, our impression based on the presentations was that the initial SAC inventory represents a good first pass at a big job. The team identified weaknesses that they are now addressing, such as the incorrect fuel ratios that were used in the initial calculations. The first version of the SAC inventory has some intentional limitations, such as being limited to ten contaminants, and being based on a limited subset of inventory records. The limitations come about principally from the way the various inventory databases at Hanford are maintained by the respective core projects. Historical inventory record-keeping systems, where much of the inventory data resides, were developed according to the needs of each project. Other inventory databases have been developed according to regulatory requirements, so any development for SAC needs may impose maintenance of duplicate data sets.

4.2 Concerns

During the open discussion, it became evident that the interface between the IP and some core projects needs further attention. At the least, we observed a communication gap. Data needed by SAC, but under the control of the core projects, must be available when needed and should be provided in an appropriate format. This may include developing and maintaining additional databases beyond the core project needs. If SAC needs such additional data, DOE-RL must ensure that they are available.

As described at the IPEP meeting, the method by which waste inventory is counted and labeled for SAC is confusing and apparently inconsistent. For example, tank waste is not counted as part of the waste inventory until it is removed and processed, while some other forms of waste, such as fuel rods in the K-basin, are considered as part of the waste inventory from the beginning. It is our view that all waste material on site should be considered part of the initial waste inventory and that inventory should be tracked "from cradle to grave" onsite.

These concerns go to the core of the purpose and goals for SAC, as the IPEP understands them:

- To assist site managers in making reasoned decisions among priorities and options for cleanup; and
- To provide a sound, credible basis for determining the level of hazard presented by the site now and over the next few centuries.

Maintaining scattered, diverse and complex sets of inventory databases is neither cost effective in the long term nor technically suitable in the near term. Common definition as to what constitutes a "waste" is a must for credible selection of options, as well as for obtaining credible estimates of the hazard presented by the options selected or rejected.

While the SAC inventory is a good first pass, it will ultimately need to be based on a detailed site-wide inventory under configuration control that is used by everyone. If that is the current plan, it was not evident from the presentation. It seems reasonable for the IP to maintain the comprehensive inventory database.

The issue of documentation of SAC Rev. 0 and the associated SAC inventory requires careful consideration. There must be enough documentation to allow effective communication and peer review, but not so much that the project devolves into a major documentation effort. One or two "white papers" that provide enough detail for peer review would probably be a useful approach, or the SAC web site could be enhanced as described earlier so it provides enough relevant technical information for a credible peer review. This should be done late in the SAC Rev. 0 cycle, but before planning is finalized for Rev. 1.

4.3 Recommendations

1. DOE should ensure that the IP has efficient access to needed data under the control of the core projects.
2. DOE and regulators should achieve a common, credible definition of what constitutes waste at Hanford and all waste should be listed in the SAC inventory.
3. DOE should ensure that a detailed site-wide inventory under configuration control is available as needed to support the SAC inventory project.
4. SAC should document the status of the SAC inventory project in a white paper or other appropriate form.
5. DOE should include relevant inventory issues as part of the SAC external peer review.
6. DOE should ensure that assignments of authority and responsibility regarding the working interface between the IP and relevant core projects are clear and appropriate for efficient interaction.

5. GROUNDWATER REMEDIATION SYSTEMS

A session on groundwater remediation systems began with a focus on the performance of the systems now in place and on IP plans for the future of groundwater remediation. Questions developed by the IPEP prior to the September meeting were developed to elicit responses to the following issues:

1. What do recent (within the past year) monitoring data indicate regarding the performance of the current groundwater remediation systems?
2. What do the recent performance data on the in situ redox manipulation (ISRM) technology indicate about the long-term effectiveness of this technology?
3. Is the current monitoring system adequate for accurate characterization of system performance?
4. Have any estimates been made on the time required to achieve cleanup goals for the various plumes being remediated?
5. Has the IP addressed long-term institutional control for the groundwater plumes that require very long-term remediation?

The presentation given to the IPEP, as well as the documents received addressed primarily questions 1 to 3. Because all groundwater remedies that have received EPA and other regulatory approval are considered "interim actions", the long-term issues and time frames have not yet been addressed. These issues will become an important component of the final remedies to be selected in 2015 for each of the contaminated zones.

5.1 Summary of Presentation

The presenters provided a four-part response to the first three questions above: 1) status of the operation, maintenance, and performance evaluation of the various groundwater pump-and-treat systems; 2) results of the CERCLA Five-Year Review, recently completed by Region 10 of the U.S. EPA [USEPA, April, 2001]; 3) implementation and continued evaluation of the ISRM technology employed as a permeable treatment zone for treatment and remediation of the hexavalent chromium, Cr(VI), plume in the 100-D area, and 4) the roadmap for soil and groundwater remediation at Hanford.

5.1.1 Status of Pump-and-Treat Systems

The Hanford Site has 11 groundwater remediation systems in the four National Priorities List (NPL) areas into which the Site is divided: the 100 Area operable unit (OU); the 200 Area OU; the 300 Area OU; and the 1100 Area OU. All remedies have been completed in the 1100 Area, resulting in the deletion of that Area from the NPL. Within the 100 and 200 Area OUs, there are several identified groundwater contaminant plumes undergoing treatment using five groundwater pump-and-treat systems; three in the 100 Area OU and two in the 200 Area OU. In addition, ISRM technology is being implemented in the 100 Area OU, and natural attenuation is invoked as a remedy at other areas. Monitoring data continue to show that the pump-and-treat systems are achieving plume capture, but gaps in the hydraulic barrier exist. A more detailed discussion of each area is provided below.

Information on the performance of each of these groundwater remediation systems has been recently documented [US DOE, August 2001].

5.1.2 CERCLA Five-Year Review

EPA's Five-Year Review ("the Review") evaluated groundwater data produced by DOE over the past several years to document compliance with the goals of the Interim Remedial Actions for the groundwater OUs in the four NPL sites. Of the 18 action items, 12 related to groundwater problems. The primary deficiency noted by EPA was insufficient capture of the chromium plumes in the 100 Area. The Review stated, "A much higher percentage of the targeted plume must be captured" [USEPA, 2001, pg. viii].

5.1.3 Evaluation of ISRM Technology

In-situ treatment of groundwater plumes containing Cr(VI) and not being captured by the pump-and-treat system is proposed by DOE as a means of reducing the concentration of Cr(VI) entering the Columbia River. This is to be accomplished through the application of the treatment technology, ISRM, that makes use of the increased sorbtion potential (on soil) of trivalent chromium. Numerous reports and peer reviewed journal articles describe the details of this technology (see Fruchter et al, 2000; Istok et al, 2001). The ISRM barrier is to be installed in three phases; the first phase of installation was completed in Oct 2000. Construction is currently scheduled to be completed in 2003. The final barrier length will be about 2300 feet.

The technology continues to demonstrate some containment of the Cr(VI) plume where the barrier has been installed. In the 100-D Area, levels of Cr(VI) directly downgradient of the barrier are reported to be below 5 ppb. However, in the treatability test zone, elevated levels of Cr(VI) were found, raising concerns over the effectiveness of the technology. These results have prompted the IP to prepare an ISRM Mitigation Plan designed to determine the cause(s) of the problem and to institute remedies that will permit continued deployment of the ISRM barrier to meet the design objectives. Accelerated depletion of the aquifer's reductive capacity may have been caused in part by heterogeneity of the aquifer, a fluctuating water table, and variability in the reduced iron content, among other possible reasons. Injection of additional dithionite in spring 2002, with a projected completion date of December 2002, was the selected remedial option.

5.1.4 Soil and Groundwater Remediation Roadmap

The Roadmap is a component of the overall site wide S&T Roadmap. This roadmap is used to plan and implement work to address scientific and technical challenges in the assessment and remediation of soil and groundwater contamination at Hanford. The major technical challenges identified by the IP relate to the remediation of ^{90}Sr, uranium, ^{99}Tc, Cr(VI), and carbon tetrachloride in groundwater. Support from the DOE Environmental Management (Subsurface Contaminants Focus Area) is considered to be an integral component of the Roadmap.

5.2 Observations and Concerns

- Although performance of the groundwater remediation systems in the 100 Area is well documented, the success of each system is difficult to assess because of uncertainties in specific performance targets, as well as variability in reported monitoring results from compliance wells.

In a previous report, the IPEP noted that monitoring data from several compliance wells in the 100 Area failed to show conclusively that the pump and treat systems were approaching performance goals for reducing the net mass discharge of Cr(VI) into the Columbia River. Fluctuations in reported Cr(VI) concentrations, apparently due in part to fluctuations in water levels along the Columbia River, make data interpretation difficult. This situation still exists, as shown by continued fluctuations in Cr(VI) levels in compliance wells downgradient of the pump and treat systems.

- Proposed system enhancements in response to EPA's Five-Year Review should improve performance of some of the groundwater remediation systems.

Based on information provided in EPA's Five-Year Review [US EPA, 2001], EPA and the Washington Department of Ecology appear to be satisfied with the level of detail provided by the DOE on the performance of the groundwater remediation systems. EPA noted, however, that the primary deficiency of the remediation systems was insufficient capture of some of the chromium-contaminated groundwater plumes. Proposed enhancements to the remediation systems include increasing the number of extraction wells, and improving the system operational reliability. The new extraction wells are designed to increase the capture efficiency of the pump and treat systems, thereby contributing to improved performance of the pump-and-treat system. Enhancements to the soil vapor extraction system in the 200 Area (200-PW-1) should also increase the amount of carbon tetrachloride removed from the vadose zone in this Area.

The Integration Project is responding appropriately to requests in the EPA Five-Year Review to improve system performance. Although the goals established by EPA are often qualitative in nature (e.g. "increase capture"), good faith efforts to meet these goals are essential to satisfy regulatory and stakeholder concerns.

- Optimization of remedial strategies is difficult without specific cleanup target levels, definition of points of compliance, and what constitutes a "reasonable time frame" for cleanup.

Because all of the groundwater remedies are considered "interim", many issues related to final cleanup have not been finalized for the groundwater plumes. Final remedies will not be decided until 2015. Regulatory goals in some instances are not explicitly defined. For example, in EPA's Five-Year Review, the DOE was directed to capture "a much higher percentage of the targeted plume" referring to the Cr(VI) plumes in the 100 areas. A definition of "much higher percentage" was not provided. It also appears that the points of compliance in the groundwater have not yet been explicitly defined. Finally, the time required to achieve presumed cleanup goals has not yet been estimated for any of the plumes. Optimization of remedial strategies requires explicit definition of these goals.

- Although the installation of the ISRM barriers has diminished the amount of chromium discharged to the Columbia river, recent high levels of Cr(VI) downgradient of the barrier raises concerns about the long-term viability of this innovative technology.

Based on the results of routine sampling activities, elevated Cr(VI) and dissolved oxygen (DO) concentrations were detected in the central well (D4-7) of the treatability portion of the ISRM barrier during 2000. Previous Cr(VI) concentrations since the dithionite injection/withdrawal in this well were near or below detection limits. As of the spring of 2001, elevated Cr(VI) and DO levels have been found in six treatability injection wells. Current Cr(VI) concentrations measured upgradient of the test site have also increased to approximately 1,600 ppb. Trends in one of the wells (D4-5) downgradient of the treatability test portion of the barrier also indicate increasing Cr(VI) concentrations there. Indications are that the residual reductive capacity of the treated aquifer has been substantially depleted within the central portion of the treatability test area.

DOE has responded to this finding by establishing a mitigation plan to determine the cause(s) of the more rapid loss of reductive capacity in the installed barrier. The mitigation plan has defined a path forward to resolve this issue.

The apparent loss of reductive capacity of the ISRM barrier is a cause for concern, because considerable effort has been invested in this innovative technology and the technology has been broadcast as a significant success story regarding DOE investments in technology development. The proposed mitigation plan represents a positive response to the problem and may be appropriate. However, insufficient evidence has been provided so far for the IPEP to evaluate its potential for successful mitigation. Sufficient resources should be devoted to this effort to ensure that the cause(s) of the problem are well defined and a successful remedy found in order to restore confidence in this technology.

Justification for the installation of the ISRM technology was largely based on a life cycle cost comparison with the conventional pump-and-treat technology. New data collected as part of the mitigation plan should provide a basis for reassessing the life-cycle advantages of the ISRM. The life-cycle cost of this technology is sensitive to the assumed life of the ISRM barrier, and a revised cost comparison should be completed to enhance the technical credibility of the technology.

- The pump and treat system in the 100-NR-2 Area addressing a large ^{90}Sr plume continues to remove only a small amount of ^{90}Sr, and the unit cost of removal is very high.

Pump-and-treat operations for ^{90}Sr began in 1995. The system has an excellent on-line history, operating continuously more than 95% of the time and with three extraction wells in operation for most of the system life. However, less than 1 curie of ^{90}Sr has been removed since inception of the groundwater extraction and treatment system and that at a unit cost of more than $4-million per curie of ^{90}Sr removed (see Appendix B, Table B3, this report). Nonetheless, the rate of plume migration to the river has been reduced because of a reduction in the hydraulic gradient. The high unit cost and the very slow rate of contaminant removal clearly indicate the need for alternative remediation strategies for this plume.

- Improved or alternative technologies for groundwater remediation are still needed, and coordination with the S&T program should continue, but it is not clear how the ongoing technical reviews will be integrated into the current groundwater remediation program.

The EPA Review has identified the need for improved pump-and-treat system performance for the ^{90}Sr plume in the 100 Area, for the carbon tetrachloride plume in the 200 Area, and for the ^{99}Tc and uranium plumes in the 200 Area (200-UP-1). DOE-RL has noted these technical challenges and the technical elements are intended to be included in the S&T roadmap. In addition, the Subsurface Contaminants Focus Area is expected to provide support to Hanford to address these technical challenges. Finally, the Los Alamos National Laboratory is currently undertaking a technology review of technical alternatives for the Hanford plumes, through the Innovative Treatment and Remediation Demonstration (ITRD) program.

The IP is pursuing a number of options to evaluate and possibly select alternative technologies for the various groundwater plumes in preparation for determining the final remedy for each plume. It was not clear from the presentation during the September meeting nor from the documents provided how the technology selection process will work. We thus recommend that the plans developed by the IP in response to the ITRD review be subjected to an external peer review to enhance their usefulness to resolve the remediation challenges at the Hanford Site.

Cost is a factor to consider for other mitigation strategies in addition to those for the ^{90}Sr plume. For example, pump-and-treat removal of Cr(VI) costs approximately $19,000 per pound of Cr(VI) removed at the 100-KR-4 Area and nearly $34,000 per pound removed at the100-HR-3 Area (see Appendix B, Tables B1 and B2, this report).

As noted, although the pump-and-treat system for the ^{90}Sr plume is capable of hydraulic containment, removal of ^{90}Sr has been very slow, and the unit cost ($4.3-million/curie removed) is very high. We have previously urged the IP to consider natural attenuation as a remedy for this plume. We reiterate that recommendation in this report as well.

Optimization of any specific groundwater remediation system will require site-specific models and other site-specific analyses. However, the SAC model can potentially be used to compare the impact of different groundwater remediation strategies on specific plumes to provide a basis for prioritization of investments in new technologies, or in optimization of currently installed technologies. It is not possible to specify when the SAC can achieve the level of credibility needed to fulfill this need for groundwater remediation systems, but we urge that this use of the SAC be given serious consideration.

5.3 Recommendations

1. Continue efforts to enhance the pump and treat systems to meet regulatory compliance goals.
2. Resolve the cause(s) of the observed breakthrough of Cr(VI) at the ISRM barrier.
3. Once the cause(s) of the decreased capacity of the ISRM barrier have been determined, reassess the cost-effectiveness of the ISRM on the basis of life cycle costs.
4. As confidence builds in the accuracy of the SAC, use this tool to assess priorities for technology selection and system optimization within the groundwater remediation program.
5. Because of the high cost of the pump and treat system for the ^{90}Sr plume, a rigorous analysis of the natural attenuation option should be a key part of any technology evaluation for this plume.

6. IP's plans to implement recommendations coming from the review by the ITRD should be subjected to an external peer review to facilitate the selection of alternative remedial technologies for the groundwater remediation program.

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Appendix A.

Agenda for September 26 – 28, 2001 IPEP Meeting

BECHTEL BUILDING ASSEMBLY ROOM

WEDNESDAY, September 26		**Moderator**
7:30 – 8:00 (AM)	On Your Own Coffee Columbia River Coffee House	
8:00 – 8:15	Welcome and Introduction DOE-RL Welcome	E Berkey K Klein
8:15 – 8:45	**Hanford Vision Update**	K Klein, M Hughes
8:45 – 9:15	Integration Project: Status and Plans (includes brief rollout of Detailed Work Plan)	M Graham
9:15 – 10:00	National Academy of Sciences Report	M Graham/M Freshley
10:00 – 10:15	Complex-wide Vadose Zone Road Map	P Wierenga
10:15 – 10:30	Break	
10:30– 12:00 (PM)	Focused Project Updates: • Tritium Investigation (618-11) • Crib Drilling Campaigns (200 RA + ORP) • Modeling Coordination Workshops • S&T Field Experiments	M Graham
12:00 – 1:00	Lunch	
1:00 – 2:30	Stakeholders, Tribal Nations, and Regulators Input	Points of Contact: IPEP: E Berkey GW/VZ IP: M Jarayssi
2:30 – 3:45	Roundtable Discussion I: Central Plateau Standards Faulk (EPA), Price (Ecology)	Points of Contact: IPEP: R Patt GW/VZ IP: M Jarayssi
3:45 – 4:00	Break	
4:00 - 5:00	IPEP Internal Administrative Meeting	
Evening	Panel Only: Working Session #1	

BECHTEL BUILDING ASSEMBLY ROOM

THURSDAY, September 27		**Moderator**
7:30 – 8:00 (AM)	On Your Own Coffee Columbia River Coffee House	
8:00 – 10:30	SAC Initial Assessment Rollout: • Initial Results	Points of Contact: IPEP: R Bassett GW/VZ IP: B Bryce
10:30 – 10:45	Break	
10:45 – 12:15 (PM)	SAC Initial Assessment Rollout (cont.): • Inventory Issues	Points of Contact: IPEP: J Conaway GW/VZ IP: C Kincaid
12:15 – 1:00	**Lunch**	
1:00 – 3:00	Groundwater Remediation Systems: • 5-year review • Enhancements • Mitigation Plans • Status of Groundwater Modeling	Points of Contact: IPEP: M Kavanaugh GW/VZ IP: G Mitchem
3:00 – 3:15	Break	
3:15 – 4:00	Stakeholders, Tribal Nations, and Regulators Input	Points of Contact: IPEP: E Berkey GW/VZ IP: M Jarayssi
4:00 - 5:00	Panel Roundtable Discussion II: **Inventory As It Relates to the SAC**	Points of Contact: IPEP: J Matuszek GW/VZ IP: M Graham
Evening	Panel Only: Working Session #2	

BECHTEL BUILDING ASSEMBLY ROOM

FRIDAY, September 28		**Moderator**
8:00 (AM) – 1:00 (PM)	Panel Only: Working Session #3	
1:00 – 2:00	**IPEP Closing Remarks**	E Berkey
2:00 – 3:00	Opportunity for Stakeholder, Tribal Nation, and Regulator Input and Comments	Points of Contact: IPEP: E Berkey GW/VZ IP: M Jarayssi
3:00 – 4:00	Panel Only: Wrap-up Session	

Appendix B.

CENTRAL PLATEAU RISK ASSESSMENT WORKSHOP

Ralph O. Patt

The USDOE held a workshop on September 11, 2001 for the three agencies that are signatories to the Tri-Party Agreement (TPA) with the goal of reaching and formalizing an agreement on exposure scenarios to support Feasibility Study analysis and remediation/closure decisions for the Central Plateau. To achieve the goal, the three parties will conduct technical meetings to discuss regulatory and technical requirements relevant to this issue. Another workshop is to be held in October 2001 with subsequent technical meetings to achieve the stated goal. The technical meetings will discuss regulatory and technical requirements with frequent consultation with the public, stakeholders and Tribal Nations prior to making final decisions on a formalized agreement.

A process for defining exposure scenarios, "cleanup levels" vs. "remediation levels", land uses and exposure parameters as defined under the Washington Administration Code (WAC) was presented. The need for interaction and coordination with all core project cleanup efforts was addressed.

B.1 Observations

Our impression from the Risk Assessment Workshop presentation is that the concept could provide the basis for improved cleanup decision-making at Hanford. Goals and processes to identify exposure scenarios necessary for cleanup decisions were outlined. The need for interaction and coordination with all core project cleanup efforts was addressed. Land-use issues and time phases of active cleanup, active institutional control and passive control were discussed. Designations of three geographic zones with alternative land-use options or scenarios, as suggested by Future Uses Site Uses Working Group (FSUWG) and various EIS, include: a Core area; a Buffer zone; and a Central Plateau Area outside the buffer zone. Processes for exposure scenarios, "cleanup levels" vs. "remediation levels", land uses and exposure parameters as defined under the Washington Administration Codes (WAC) also were presented. Our impression from the Risk Assessment Workshop presentation is that the three parties are making some progress in achieving agreement on exposure scenarios necessary for cleanup decision-making at Hanford. Agreement on the process by the three parties is necessary for moving forward on cleanup. Essential congressional support could be lost if it appears there is fundamental disagreement on a cleanup process by the three parties, stakeholders and Tribal Nations.

B.2 Concerns

Agreement was reached at the workshop by the three parties regarding a time frame for Central Plateau cleanup; active cleanup (50 years), followed by active institutional control (100 years), followed by passive control such as barriers and natural decay (attenuation) after 150 years.

These time frames may not be realistic because of the lack of federal budget support, new information, more precise analytical technology, new options from changing technology, better understanding of human risk and options for amelioration of harmful effects, and changing public perceptions of human and ecological risk.

The above cleanup and control periods are linked to the "End Points" and "End States" as outlined by DOE. Unfortunately, the two terms have not been clearly defined and that there is public confusion about them.

The three parties have apparently strong disagreement on cleanup strategy in some cases. All parties need to work toward achieving unified agreement on cleanup goals, processes, and implementation strategies.

There is public confusion and disagreement about:

- Defining risk and then setting land-use scenarios or
- Setting land-use goals and then attempting cleanup to minimize risks associated with the selected land use.

B.3 Conclusions

The Central Plateau Risk Assessment Workshops, spearheaded by the IP and the regulators (EPA and Ecology), have the potential to achieve consensus on both "End Points" and "End States" related to the Central Plateau.

Appendix C

GROUNDWATER REMEDIATION SYSTEMS

Dr. Michael C. Kavanaugh

The Hanford Site was placed on the National Priorities List (NPL) in 1989 and was divided into four NPL sites: 100 Area; 200 Area; 300 Area; and1100 Area. Each area was further subdivided into operable units. There are 11 groundwater operable units (OUs) in these four Areas. All remedies have been completed in the 1100 Area, resulting in the deletion of that Area from the NPL

Information on the performance of each of these systems has been recently documented (US DOE, August 2001). Examples of the types of information provided by DOE at two of the pump-and-treat sites are summarized in Tables C1 and C2 below (US DOE, August 2001).

Table C1. 100-HR-3 Pump-and-Treat System Performance

	100-H Area	100-D Area
Beginning of full-time operation (pump-and-treat)	Jul-97	Jul-97
Total amount of groundwater extracted	505 million liters	453 million liters
Total amount of Cr(VI) removed	25 kilograms	79 kilograms
Avg. Cr(VI) system influent conc. in 2000	34 ppb	192 ppb
Avg. Cr(VI) system effluent conc. in 2000	7 ppb	7 ppb
Removal efficiency in 2000	93 percent	
Removal efficiency in 1999	98 percent	
Resin changes in 2000	27	
Resin changes in 1999	18	
Avg. life of resin vessel	133 days	98 days
Overall system availability (incl. scheduled outages)	> 97 percent	
On-line availability	96 percent	
Avg. process flow rate	378 L/min (95 gpm)	286 L/min (70 gpm)
Pumping rates per well	45 to 147 L/min (10 to 35 gpm)	
Treatment costs per liter of groundwater	$0.007	
Treatment costs per gallon of groundwater	$0.03	
Treatment costs per gram of Cr removed	$74	

Table C2. 100-KR-4 Pump-and-Treat System Performance

	100-KR-4 Area
Beginning of full-time operation (pump-and-treat)	Oct-97
Total amount of groundwater extracted	908 million liters
Total amount of Cr(VI) removed	114 kilograms
Avg. Cr(VI) system influent conc. in 2000	123 ppb
Avg. Cr(VI) system effluent conc. in 2000	6 ppb
Removal efficiency in 2000	95 percent
Removal efficiency in 1999	Lower than 2000
Resin changeouts in 2000	26
Resin changeouts in 1999	20
Avg. life of resin vessel	112 days
Overall system availability (incl. scheduled outages)	> 98 percent
On-line availability	96 percent
Avg. process flow rate	600 L/min (75 gpm)
Pumping rates per well	88 to 123 L/min (20 to 30 gpm)
Treatment costs per liter of groundwater	$0.005
Treatment costs per gallon of groundwater	$0.02
Treatment costs per gram of Cr removed	$41

Pump-and-treat operations for Sr-90 began in 1995. The system has an excellent on-line history, with three extraction wells in operation for most of the system life. Treated groundwater is injected upgradient via two injection wells. Performance assessment data for the pump-and-treat system operations at 100-NR-2 are given in Table C3 taken from the DOE report (USDOE, August 2001). As noted, less than 1 curie of Sr-90 has been removed since inception of the groundwater extraction and treatment system, at a unit cost of more than $4 million per curie removed. Nonetheless, the rate of plume migration to the river has been reduced, because of a reduction in the hydraulic gradient. The pump-and-treat system has been estimated to be capable of reducing the net flux of groundwater entering the Columbia River by 96%. (USDOE, August 2001). The high unit cost and the very slow rate of contaminant removal clearly indicate the need for alternative remediation strategies for this plume.

Table C3. 100-NR-2 Pump-and-Treat System Performance

	100-NR-2 Area
Beginning of full-time operation (pump-and-treat)	Sept-95
Total amount of groundwater extracted	552 million liters
Total amount of Sr-90 removed	0.91 curies
Avg. Sr-90 system influent conc.	1,972 pCi/L
Avg. Sr-90 system effluent conc.	377 pCi/L
Avg. removal efficiency	90 percent
Overall system availability (incl. scheduled outages) 4th Qtr 1999	> 92 percent
Overall system availability (incl. scheduled outages) 2000	> 96 percent
On-line availability 4th Qtr 1999	76 percent
On-line availability 2000	86 percent
Avg. process flow rate	200 L/min (60 gpm)
Pumping rates per well	51 to 120 L/min (10 to 30 gpm)
Treatment costs per liter of groundwater	$0.007
Treatment costs per gallon of groundwater	$0.03
Treatment costs per Curie of Sr-90 removed	$4.293 million